

Claims

- [c1] 1. An improved method of determining a human body tissue analyte concentration by non-invasive measurement of emission spectral lines characteristic to a body tissue analyte in an infrared spectral region emitted naturally by a human body as heat, comprising:
- a) measuring a spectral intensity of said emission lines;
 - b) said emission spectral lines having a wavelength dependence of tissue constituents;
 - c) detecting the emission spectral lines at a predetermined emission wavelength;
 - d) analyzing the emission spectral lines in said infrared spectral region;
 - e) measuring ambient temperature;
 - f) measuring optionally ambient humidity;
 - g) measuring body temperature by means of heat conduction;
 - h) measuring body temperature in a non-contact manner by means of radiation;
 - i) correlating said spectral intensity of emission spectral lines, said ambient temperature and said optional humidity, said body temperature measured

by means of conduction and means of radiation with body analyte concentrations.

- [c2] 2. The improved method as in claim 1, for determining blood glucose concentration by non-invasive measurements of emission spectral lines characteristic to a body tissue analyte in an infrared spectral region emitted naturally by a human body's tympanic membrane in an infrared wavelength spectrum as heat including measuring of ambient and body temperature and optionally ambient humidity.
- [c3] 3. An improved instrument for determining a human body tissue analyte concentration by non-invasive measurement of emission spectral lines characteristic to a body tissue analyte in an infrared spectral region emitted naturally by a human body as heat, comprising:
- a) a means for detecting said emission spectral lines at a predetermined infrared wavelength;
 - b) a means for detecting a spectral intensity of the emission spectral lines;
 - c) a means for measuring ambient temperature;
 - d) an optional means for measuring ambient humidity;
 - e) a means for measuring body temperature by means of heat conduction;
 - f) a means for measuring body temperature in non-

contact manner by means of radiation;

g) a means for correlating said spectral intensity of emission spectral lines, said ambient temperature and said optional humidity, said body temperature measured by means of conduction and means of radiation with body analyte concentrations.

[c4] 4. The improved instrument of claim 3 wherein the detecting means comprises:

a) a detector means; and,

b) an analyzing means in the form of a wavelength selecting means for the emission spectral lines;

said detector means comprising means for detecting the intensity of received emission spectral lines from said analyzing means producing an electrical output signal; said wavelength selecting means comprising means for allowing only significant wavelengths of tissue analyte emission spectral lines in natural infrared radiation emitted by the human body to reach the detector means.

[c5] 5. The improved instrument of claim 3 wherein the measuring means comprises sensors for said temperature and optionally sensors for said humidity measurements.

[c6] 6. The improved instrument of claim 4, wherein the detector means comprises an infrared energy sensor for infrared energy measurements.

- [c7] 7. The improved instrument of claim 4, wherein the analyzing means comprises filter means for filtering the emission spectral lines to allow only for wavelengths significant to the tissue analyte emission spectral lines to pass or to be absorbed before reaching the detector means.
- [c8] 8. The improved instrument of claim 3, where the correlating means is an electronic means comprising electronics and a microcomputer for correlating the electronic output signal from the detecting means and measuring means with the tissue analyte concentration.
- [c9] 9. The improved instrument as in claim 3, for determining blood glucose concentration by non-invasive measurements of emission spectral lines characteristic to blood glucose as a body tissue analyte.
- [c10] 10. An improved instrument for non-invasive tissue analyte concentration measurements based on measurements of emission spectral lines characteristic to a human body tissue analyte in an infrared spectral region emitted naturally by a tympanic membrane as heat, comprising:
- a) an ear plug assembly for insertion into an ear canal;

b) said ear plug assembly comprising an infrared radiation detecting system comprising an optical infrared filter set and a detector sensitive in an infrared region of human body heat radiation for detecting the emission spectral lines, and providing an output based thereon;

c) said ear plug assembly comprising a body temperature measurements sensor by means of conduction;

d) said ear plug assembly comprising a body temperature measurements sensor by non-contact manner by means of radiation;

e) a sensor for ambient temperature measurements;

f) an optional sensor for ambient humidity measurements;

g) said ear plug assembly and said sensors comprising connection means whereby the output of the detecting system may be connected with electronics, a microcomputer and a display system for forming, calculating, and displaying an electrical signal from the said detecting system and said sensors to show a numerical value of the analyte concentration.

[c11] 11. The improved instrument of claim 3 and 10 wherein said detecting system incorporating body temperature sensor is adapted to be in thermal conductive contact with a human body.

- [c12] 12. The improved instrument as in any one of claims 3, 4, 5, 6, 7, 8, 9, 10 or 11 wherein said detecting of said emission spectral lines and said spectral intensity of the emission spectral lines and said detecting of temperature and optionally humidity are effected continuously.
- [c13] 13. The improved instrument of claim 12 wherein the emission spectral lines are the emission spectral lines of blood glucose.
- [c14] 14. The improved method as in any one of claims 1 or 2 wherein the measuring of the spectral intensity of said emission lines and the detecting of the emission spectral lines and said detecting of temperature and optionally humidity are effected continuously.
- [c15] 15. The improved method as in claim 14 wherein the emission spectral lines are the emission spectral lines of blood glucose.
- [c16] 16. An improved instrument for determining a human body tissue analyte concentration by non-invasive measurement of emission spectral lines characteristic to a body tissue analyte in an infrared spectral region emitted naturally by a human body as heat, comprising:
- a) a speculum for insertion into an ear canal;
 - b) an optional plastic cover made of material trans-

- parent to radiation in an, infrared spectral region;
- c) an infrared wave-guide for receiving infrared radiation from the tympanic membrane and for illuminating all windows of a detecting system;
- d) said infrared wave-guide being selected from the group consisting of a mirror, reflector, lens, hollow tube, and a fiber optic;
- e) the detecting system consisting of:
 - i) an infrared filter set; and,
 - ii) a detector sensitive in an infrared region of human body heat radiation;
- f) an optical infrared filter set consisting of a negative correlating filter or narrow band filters;
- g) a detector system sensitive in an infrared region of human body heat radiation consisting of at least two sensing areas electronically connected so that their outputs are subtracted;
- h) the detector system comprising a body temperature sensor by non-contact means e.g. radiation;
- i) said speculum optionally comprising a body temperature sensors by conduction;
- j) a sensor for ambient temperature measurements;
- k) an optional sensor for ambient humidity measurements; and,
- l) said detector and said sensors having an output

connected with electronics, a microprocessor and a display system for forming, calculating, and displaying a resulting electrical signal from the detector and sensors to show a numerical value of the analyte concentration.

- [c17] 17. An improved instrument for non-invasive tissue analyte concentration measurement based on measurement of emission spectral lines characteristic to human body tissue analyte in an infrared spectral region emitted naturally by tympanic membrane as heat, comprising:
- a) a speculum for insertion into an ear canal and for receiving from an infrared wave-guide infrared radiation from the tympanic membrane and for illuminating all windows of a detecting system;
 - b) the detecting system comprising:
 - i) an optical infrared filter set consisting of a negative correlating filter or narrow band filters; and,
 - ii) a detector sensitive in an infrared region of human body heat radiation, said detecting systems positioned to be illuminated by infrared radiation arriving from said optical infrared filter set, or negative band filters, and having at least two sensing areas electronically connected so that their outputs are subtracted to produce a detection output;

- iii) a body temperature sensor by non-contact means e.g. radiation;
- c) said speculum optionally comprising a body temperature sensors by conduction;
- d) a sensor for ambient temperature measurements;
- e) an optional sensor for ambient humidity measurements; and,
- f) said detector and said sensors having an output connected with electronics, a microprocessor and a display system for forming, calculating, and displaying an electrical signal from the detector and sensors to show a numerical value of the analyte concentration.

[c18] 18. An improved instrument as in claim 17 wherein the infrared wave-guide is selected from the group consisting of a mirror, reflector, lens, hollow tube, and a fiber optic.

[c19] 19. The instrument as in any one of claims 17 or 18 wherein the emission spectral lines are the emission spectral lines of blood glucose.